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then colored from nature. It is a little enlarged. Figs. 6 and 7 were drawn and tinted from specimens under the microscope.

It is a pleasure to acknowledge my indebtedness to Mr. Baldwin Coolidge for the care and skill with which he has reproduced the original colors. (Fig. 3 is by the author.)

Figure 1. Spring color-change without 'moult' of the feather. An old feather of the color of the spring plumage. (March 1, Brazil, Corumbá. Coll. American Mus. Nat. Hist., No. 32783.)

Figure 2. Spring 'moult' without color-change in the feather. A new-growth feather the color of the winter dress. (March 1, Brazil, Corumbá. Same skin as preceding.)

Figure 3. Spring color-change without 'moult' of the feather. The first black feather seen on my Bobolink. (March 28, cage-bird.)

Figure 4. Fall 'moult' without color-change of the feather. A new feather, but the color of the preceding plumage. (August 29, Minnesota. Coll. Amer. Mus. Nat. Hist., No. 52326.)

Figure 5. Fall 'moult' with partial color-change of the feather. A new-growth feather, showing the 'foci' of darker shade, partly obscured by the yellow of the fall dress. (August 2, New York. Amer. Mus. Nat. Hist., No. 32785.)

Figure 6. Spring feather, transverse section. From a deep black feather of the breeding dress, in its terminal third. Granules of coloring matter, chiefly massed peripherally, producing the effect of black. (May 30, Mass. Coll. A. P. C., No. 2672.)

Figure 7. Fall feather, transverse section. Like Fig. 6, but of the Reed-bird type. Granules not massed peripherally, but scattered throughout. (September 17, Mass. Coll. A. P. C., No. 3522.)

(Figs. 6 and 7 with Zeiss 4 mm. apochromat. objective, and No. 6 comp. ocular.)



REMARKS ON THE SPRING MOULT OF THE BOBOLINK.

BY FRANK M. CHAPMAN.

IN his paper on "The Spring Plumage of the Bobolink, with Remarks on 'Color-Change' and 'Moult,'" published in this number of 'The Auk,' Dr. Chadbourne has shown that captive

Bobolinks may change from the winter or Reedbird plumage to the black, buff and white dress of the breeding male without moulting. The discovery is of such importance and has so wide a bearing upon problems connected with changes of color in the plumage of birds, that, having handled a large part of the material which Dr. Chadbourne has studied, it has seemed advisable to follow his paper with remarks upon several questions he has therein discussed.

Laying aside for a moment the fact that the change observed occurred in a caged bird, we have here for the first time a definite description of a change in the color of a bird's plumage without moult with an explanation of its cause in certain feathers. This change, it should be noted, is not due to repigmentation, or "influx of new pigment," which has so often been spoken of as an observed fact, nor even to a chemical change in the pigment, but to a redistribution in the shaft or barb of the feather, of the existing pigment. Dr. Chadbourne says: "Thus in the black spring specimen the granules are peripheral and comparatively close together, though a smaller number are also found in the deeper parts; while in the autumn the granular pigmented matter is more uniformly scattered throughout." It will be observed therefore that no vascular connection between the feather and the dermal papilla in which it is set is claimed, nor is there any evidence to show that the feather can renew itself either by repigmentation, or by a fresh growth restoring a worn or ragged feather to its perfect shape, as claimed by Herr Gätke and other theorists. It is these two theories, repigmentation and new growth in an old feather, that Dr. Allen and others have combated as physiologically impossible, and Dr. Chadbourne alone of all the advocates of color-change without moult, has shown that this change may take place by a comparatively simple process, which nevertheless accomplishes remarkable results.

In demonstrating his point Dr. Chadbourne has placed in our hands a very dangerous tool. It is evident that extreme care is necessary in conducting observations of the kind he has made, and that satisfactory results can only be obtained through continued observation of the same individual.

It is of course well known that cage-birds may moult very irregularly, and this is particularly true of Bobolinks. Dr. Allen¹ records numerous individuals moulting in the spring while Dr. Chadbourne's specimen lost practically no feathers at that season. In a bird store in New York City at this time (November) are two male Bobolinks still wearing the black breeding dress. Before admitting, therefore, that the changes which occur in the plumage of a cage-bird may also take place in birds in a state of nature, it will be well to examine that part of Dr. Chadbourne's paper relating to the specimens of wild Bobolinks he has studied. This refers largely to the Corumbá, Brazil, specimen (Am. Mus. No. 32783) figured in a previous number of this journal.² In describing this specimen,³ I have said that it was passing from the Reedbird to the black Bobolink plumage by a *complete* moult. In fact the only feathers of the old plumage remaining are the first primary and five inner secondaries of the right wing, four inner secondaries of the left wing, the primary coverts and scapularies of both wings, and some of the under wing-coverts. Old contour feathers may be found in the centre of the back and in small numbers about the head, neck, and upper breast. In all these parts the moult is in progress and these old feathers would evidently soon have been replaced by those of the new plumage. The centre of the lower breast and the centre of the abdomen are still occupied by the old plumage, the feathers of this part being, as in the adult Reedbird, white tinged with yellow. An August moulting, adult Bobolink has nearly acquired the Reedbird plumage but, as in the Corumbá bird, the feathers of the middle of the abdomen have not as yet been moulted, apparently showing that these feathers are the last to be shed.

¹ Bull. Am. Mus. Nat. Hist., VIII, 1896, p. 44.

² The Auk, X, 1893, p. 309. Dr. Chadbourne's remarks upon this plate (*antea*, p. 141) would imply that acting under my instructions, the artist had partially completed the moult of the Corumbá bird therein figured, and I must confess that my own statement regarding it would lead one to the same conclusion; but as I was not in this country when either the drawing or lithograph was made and, beyond the fact that the plate was contemplated, knew nothing whatever about it, I can hardly be held responsible for its inaccuracies.

³ The Auk, VII, 1890, p. 120.

Dr. Chadbourne has examined this Corumbá specimen, but his conclusions differ from my own. In brief, he says that the moult is not a complete one, but that certain feathers of the winter plumage have changed to the color of the breeding plumage, and that in the white area of the abdomen there are some white feathers not fully mature. He further says: "My Bobolink showed none of this white marking on the breast or abdomen, nor did it have the chestnut shading, which is so prominent in the Corumbá specimen, and Dr. Allen says nothing of any similar coloring among the birds seen by him. When we call to mind the fact, to be referred to later, — that the black of the Bobolink is really due to brown, instead of black coloring matter, — it is at once clear that the excess of chestnut and white show a lack of the normal quantity of pigmented matter; and it seems almost sure that in the Corumbá bird, we have not a normal example, but a partial albino!"

In attempting to explain the reason for this difference in Dr. Chadbourne's opinion and my own, let us first consider the question of change in the color of an old feather (figure 1 of the plate accompanying his paper). The plumage of the Reedbird, especially of adult specimens, often contains black feathers, the terminal yellow tips of which show them to be new. Dr. Chadbourne figures such a feather in his plate (fig. 1). What becomes of these feathers? In an adult male taken September 25, in Jamaica, W. I. (Am. Mus. No. 42134) nearly all the feathers of the breast and sides are so marked. The bird could not well lose them without these parts becoming featherless. There is no reason to doubt, therefore, that they are retained until the spring moult, and in my opinion it is on one of these black feathers that Dr. Chadbourne bases his statement of spring color change without moult of the feather in the Corumbá specimen, when in truth there is no evidence whatever to show that this feather was not black when it was acquired at the preceding moult.

As to the "not fully mature feathers" which Dr. Chadbourne reports finding in the white area on the lower breast and abdomen of the Corumbá bird, one of which he figures (fig. 2), I must confess that after the most careful search I have failed to

find a single new white feather in this or any part of the bird's plumage. I do find, however, new black feathers appearing, and there is in my mind, no doubt but that in due time these yellowish white feathers of the fall plumage would have been replaced by the black ones of the spring plumage.

And this brings me to Dr. Chadbourne's statement that these white feathers and a "chestnut shading" are evidence of albinism in the Corumbá specimen, neither of them being shown in his cage-bird. As for the white feathers in the abdomen, allowing for a slight fading and abrasion due to their having been worn for a longer time, they are exactly like those found in the same part of several Reedbirds in the collection of the American Museum. In other words, they appear perfectly normal and are in no way albinistic. The "chestnut shading" mentioned by Dr. Chadbourne as an evidence of albinism in the Corumbá bird, and as not shown by his cage-bird, I am unable to detect. In any event, it is obvious that the two birds are not comparable. With the exception of the white abdominal area the few old feathers remaining in the plumage of the Corumbá bird do not materially effect its color, which is that of the newly grown feathers, while Dr. Chadbourne's cage-bird was acquiring its spring dress not by moult, but by change of color in the old feathers. I think, therefore, that Dr. Chadbourne is mistaken when he states that the Corumbá bird is "apparently a partial albino," and I must again assert my belief that this bird is acquiring its breeding plumage by a *complete* moult.

Admitting this, it may be said that one moulting specimen does not prove that all wild Bobolinks moult in the spring, and, in replying to this objection, I am very glad to find that Dr. Chadbourne and myself are in accord as to what constitutes evidence of spring moult in the Bobolink. Speaking of his cage-bird he says: "The buff edging of the breast feathers was never more than a narrow line, evidently owing to the absence of the long fugaceous tips, which are so characteristic of the newly developed feathers, and it is therefore probable that spring males showing much buff suffusion beneath have recently passed through a 'spring moult,' or at least through a partial feather change." It is these tips which give the freshly moulted Corumbá bird so

singular an appearance, and they are undoubted proof of new growth.

In the Corumbá bird they form about the terminal fifth of the feather. Thus a breast feather measures, from tip to insertion, .75 of an inch, of which the buff tip occupies .15 of an inch. A feather from the same region in a June Bobolink, from which the tip has fallen, and which is further worn, measures only .50 of an inch. There can be no reason to question therefore that feathers having these tips are recently grown. I emphasize the point, for I have yet to see an April Bobolink, and I have examined numerous specimens, in which these tips were not prominent. It is, therefore, not alone upon the Corumbá specimen but upon these April birds that I base my theory of a spring moult in *Dolichonyx*. How or when a caged Bobolink may change plumage no man can predict but among wild birds there is as yet no recorded evidence that the breeding plumage is not acquired by a complete moult.

DESCRIPTIONS OF TEN NEW SPECIES OF BIRDS DISCOVERED BY DR. W. L. ABBOTT IN THE KILIMANJARO REGION OF EAST AFRICA.¹

BY CHARLES W. RICHMOND.

A VERY valuable collection of birds made several years ago in the Kilimanjaro region of East Africa and presented to the United States National Museum by Dr. W. L. Abbott, not only supplied to the Museum many species previously unrepresented in its collections, but contained numerous species new to science. Various causes, mainly lack of material for comparison, have prevented the correct determination of a large part of the collection, although recently, through the generosity of Mr. A.

¹ By permission of Mr. F. W. True, Executive Curator, U. S. National Museum.